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ABSTRACT

A survey of chairpersons of the Departments of Economics at 47 accredited U.S. colleges and universities collected data concerning required and recommended courses, departments in which students take the courses, satisfaction with the courses, and problems in those courses where respondents indicated dissatisfaction. Results indicated that: (1) the quantitative course most often required of economics majors is statistics, with 98 percent of institutions requiring it; (2) calculus was required at almost two-thirds of institutions and linear algebra at one-fourth; (3) statistics was taught in economics departments 43 percent of the time and in mathematics departments 35 percent of the time, while calculus and linear algebra were taught in mathematics departments almost 90 percent of the time; (4) respondents were more satisfied with quantitative courses not taken in mathematics/computer science departments; (5) in private institutions, 94 percent of computer programming and 80 percent of computer tool courses were taught in mathematics/computer science departments, while in public institutions, percentages were 50 and 33 percent respectively; and (6) the most frequently cited area of dissatisfaction was the lack of theoretical applications. The paper concludes that quantitative courses should stay in the mathematics and computer science departments, and instructors from these departments should include more problems applying quantitative skills to the economics field. (JDD)

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A Survey of the Impressions of Economics Departments of the Quantitative Courses Required of Economics Majors

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Introduction.

Many students of economics do not realize the importance of strong quantitative skills to their discipline. The concepts used in economics courses are, in fact, applications of mathematics. A working knowledge of calculus, linear algebra, statistics, and computer skills are essential for a thorough understanding.

The increasing importance of mathematics to various disciplines, not only economics, is evident. More areas outside the departments of mathematics and computer science are offering and requiring quantitative courses. Conversely, as the demand for mathematical skills is increasing, the number of students enrolled in the upper division mathematics and computer science classes is unfortunately diminishing.

Objectives.

The first objective of this study was to determine those quantitative courses that are either required or recommended for Economics majors. These courses include algebra, calculus, linear algebra, differential equations, statistics, computer programming and computer tool skills courses(data base, word processing, spreadsheet, etc.). Since much of economics depends on mathematical models, these courses are very important.

The second objective was to determine the departments responsible for the quantitative courses required of the Economics majors are being taught. Many courses that were traditionally taught by mathematics departments have become so theoretical that other

departments are teaching courses where applications need to be stressed. This same situation is now occuring with computer courses. Statistics courses required of Economics majors are often taught in departments within business colleges or even in psychology departments. Many computing courses are now being taught in departments other than mathematics or computer science departments.

The third objective, then, was to determine the degree of satisfaction that Chairpersons of Departments of Economics have with the quantitative skills courses and how they believe these courses may be improved.

Perspective or Theoretical Framework.

Students in mathematics, statistics, and computer science courses often become so lost in the theory that they fail to see the applications. This problem was noted by William P. Thurston and is summed up by the following quote:

> There is a natural tendency, in teaching mathematics, to use the logical order and to explain all the techniques before bringing up the examples and the questions, on the supposition that the students will be equipped with all the techniques necessary to answer them when they arise.[1]

The number of application problems in quantitative courses is decreasing. Many department chairpersons and faculty members are not satisfied with the content of the required quantitative courses for their classes, a conclusion reached in analyzing data for a survey conducted by Garfunkel and Young. In this survey Garfunkle and Young address the problem of limited applications of mathematics to other disciplines. The situation may be summarized by the statement one respondent made to this survey:

> I cannot take it for granted that [students of calculus] are able to use their mathematical skills in problems solving. What appears to be...lacking is the ability to formulate a problem quantitatively and then to solve it using tools they learned in their calculus course.[2]

In the preface of the text Fundamental Methods of Mathematical Economics, the author, Alpha C. Chiang stated the frustration students often have taking quantitative courses:

> Unfortunately, studying mathematics is, for many, something akin to taking bitter medicine...necessary and inescapable, but extremely tortuous. Such an attitude, referred to as "math anxiety", has its roots...I believe largely in the inauspicious manner in which mathematics is often presented to students. In the belief that conciseness often means elegance, explanations offered are sometimes too brief for clarity, puzzling students, and giving them an undeserved sense of intellectual inadequacy.[3]

This was the motivation Chiang expressed for the writing of a textbook for Economics majors designed specifically to teach them the concepts of linear algebra, calculus, differential equations, and linear programming.

Method.

A survey instrument was designed by the authors to assess the cited objectives. This survey instrument consisted of four sections: 1) a check list of required and recommended courses; 2) a check list for the department in which the students take the courses; 3) a satisfaction scale for each course; 4) a check list for problems in any course where the respondent indicated dissatisfaction.

The ranking of the courses as required, recommended, or not essential was considered as an ordinal scale, while the satisfaction scale was considered to be an interval scale.

One hundred institutions were randomly selected from accredited colleges and universities in the United States. Fifty of the

institutions surveyed were public institutions and the remaining fifty were private institutions. The authors did not use a stratified random sample because there are more private universities than there are public universities. However, the authors believe that there are more students studying economics at public universities than at private universities. The institutions were selected by using random numbers generated by a computer program written by the authors. These surveys were sent to the Chairpersons of the Departments of Economics at the institutions included in this survey.

The responses to the survey items were tabulated. In order to determine if any differences exist between public and private institutions for the satisfaction scales, one-way analysis of variance was utilized. The chi-square statistic was used to examine differences on other scales.

Results.

Of the 52 suveys returned, a 52% return rate, five indicated that the institution did not offer an Economics major. Therefore, 47 questionnaires were available for analysis. Of these usable surveys, 21 were private liberal arts colleges, seven were public universities with enrollments of 20,000 or less, 12 were public universities with enrollments of over 20,000, four did not fit any of the categories listed, and three did not indicate the type of institution.

Percentages of quantitative courses required, recommended but not required, and considered as not essential by the institutions

responding to the questionnaire are presented in Table 1.

Table 1
Percentages for Quantitative Course Requirement Type

	Required	Recommended but Not Required	Not Essential
Calculus	65.9	29.5	4.5
Statistics	97.7	0.0	2.3
Linear Alg	24.4	46.3	29.3
Diff. equ.	10.3	30.8	59.0
Computer Prog	23.1	25.6	51.3
Computer tools	52.4	38.1	9.5

The quantitative course most often required of Economics majors is statistics with almost 98% of the institutions surveyed requiring this course. Less than two-thirds of the institutions require calculus. However, calculus is needed for a good understanding of continuous distributions.

Much of modern Economics involves the study of linear models. Yet, linear algebra was required by slightly less than one-fourth of the institutions surveyed. Differential equations facilitates an understanding of the rate of change of one variable with respect to another. Yet, only slightly more than 10% of the institutions for which repsonses to this the survey were received require this course.

It is interesting to note the departments in which students take the quantitative courses. These results are displayed in Table 2.

Table 2

Percentages of Various Courses Offered By Particular Academic Departments

	Math/CS	Economics	Other
Calculus	89.1	8.7	2.2
Statistics	34.8	43.5	21.8
Linear alg	87.2	10.3	2.6
Computer prog	77.1	5.7	17.2
Computer tools	60.0	17.8	22.2

While calculus was taught in the mathematics departments almost 90% of the time, statistics was taught in this department for less than 35% of the responding institutions. A course in computer tools, such as spread sheets and data bases, was required more often than a course in computer programming, yet was less likely to be taken in a mathematics or computer science department than a computer programming course was.

When the Chairpersons of Departments of Economics were asked to rate their satisfaction with the quantitative courses that their students take, the results indicated a higher satisfaction with quantitative courses not taken in the mathemetics or computer science departments. These results are presented in Table 3.

Table 3

Satisfaction With Quantitative Courses

	Very Satisfied	Somewhat Satisfied	Neutral	Somewhat Dissatisfied	Very Dissatisfied
Calculus	31.7	39.0	14.6	12.2	2.4
Statistics	31.0	47.6	14.3	7.1	0.0
Linear alg.	40.0	30.0	23.6	6.7	0.0
Computer pro.	33.3	11.1	48.1	7.4	0.0
Computer tool	38.2	38.2	14.7	8.8	0.0

Although linear algebra had the highest percentage of respondents in the "Very Satisfied" category, less than one-fourth of the Economics departments required this course. More than 50% of the respondents responded "less than satisfied" for the course computer programming, a cuorse most often taught in a mathematics or computer science department.

The only differences between public and private institutions that appeared in the survey was for the department where students took the computer courses. In private institutions, 94.1% of the computer progamming courses were taken in mathematics/computer science departments, while in public institutions, only 50% of the computer programming courses were taken in mathematics/computer science departments. The difference yielded a chi-square value, when corrected for continuity, of 5.67, which, with one degree of freedom, is significant at the .017 significance level. For computer tool courses, the results were even more pronounced. Eighty percent of the Economics majors in private institutions took this course in mathematics/computer science deparments, while only 33.3% of the Economics majors in public institutions took this course in a mathematics/computer science department. The resulting chi-square value was 8.46, which, with one degree of freedom, is

significant beyond an alpha level of .01.

When an anlysis of variance was applied to the satisfaction scale, no discernable differences were found between public and private institutions. The most frequently cited problem for all the courses was the lack of applications of the theory.

Conclusions.

The one difference between public and private institutions is notable. Why are private institutions teaching computer classes in the mathematics or computer science departments while public schools are tailoring these courses for specific majors?

It is a known fact that private institutions do not have the funds available to them that state schools have. Therefore, they do not have the same resources to commit to the proliferation of courses. It is also important to note that the quality of education in the private schools is often rated superior to that of the public schools. Perhaps this proliferation of courses may have something to do with the perceived quality of education.

Various departments teaching their own versions of statistics, computer tools, and mathematics courses describe a current trend that is taking place in public universities all over the United States. Also, many mathematics departments are teaching a calculus course designed for business majors that many students of economics take. This proliferation of courses was deemed necessary to ensure students would have at least minimal quantitative skills.

The majority of Economics departments reported a general satisfaction with these courses; especially the courses taught in their own departments or colleges. One may assume, based on these findings that students are acquiring adequate skills. However, it is a fact that United States students do not have the necessary quantitative skills at all educational level. The *Mathematical Scienes Education Board* stated the case as follows:

> Current mathematics achievement of U.S. students is nowhere near what is required to sustain our nation's leadership in a global technological society.[4]

In the opinions of the authors mathematical concepts are bastardized in these "tailored " courses. Few, if any, logical explanations are stressed in the lectures or texts. Many of these courses treat mathematics merely as a heap of formulas to be memorized and undoubtedly will soon be forgotten. However, a degree of memorization is essential in order to use concepts, The focus should not be on how well students can memorize and accurately regurgitate formulas, but how well they understand the theory behind the formula. This is what allows them to use formulas as powerful tools when solving problems. Yet, they cannot be expected to understand the logic, if, when asked a question pertaining to the theory, they receive an explanation of the problem via the analogy of the caterpillar changing into the butterfly. This explanation disregards the fact that there are sound theoretical principles that explain the concept and leaves the impression thse principles just inexplicably come into being.

In his book Why the Professor Can't Teach, Morris Kline addresses this very problem.

> the author's and publisher's names seemed to differentiate them. The contents were about the same, whether the authors in their prefaces or the publishers in their advertising literature professed to address liberal arts students, prospective engineers, students of business, or prospecive teachers. Motivation and the use of the mathematics were entirely ignored. It was evident that these authors had no idea what anyone did with mathematics.[5]

The courses should stay in the mathematics and computer science departments, and instructors from these departments must be willing to include more problems applying quantitative skills to various fields. Seeing applications of mathematics, computer science, and statistics in an area such as economics should be of benefit to the mathematics or computer science major. Seeing an application of the theory serves to motivate learning. Thus, it should be deemed necessary to provide a proper balance between theory and application.

Works Cited

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3. Chiang, Alpha C. Fundamental Methods of Mathematical Economics, McGraw-Hill, Inc. New York, 1984, page x.

4. O'Neil, John; Raising Our Sights: Improving Achievement in Mathematics and Science, Association for Supervision and Curriculum Development, Alexandria, Va. 1991, p.v.

5. Kline, Morris; Why the Professor Can't Teach, St. Martin's Press, New York, 1977, pg. 19.

III. Satisfaction with courses

	Very Satisfied	Somewhat Satisfied	Neutral	Somewhat Dissatis-fied	Very Dissatis-fied
Calculus					
Statistics					
Linear algebra					
Computer programming					
Computer tools					

IV. If dissatisfied with any course, indicate the problem.

	Needs more applications	Needs more content	Needs more problems	Other
Calculus				
Linear algebra				
Statistics				
Computer Programming				
Computer tools				

Please indicate the type of institution in which you are employed:

____private liberal arts college

_____public university with enrollment 20000 or less

____public university with enrollment greater than 20000

____other(specify):

V. Additional comments. You may use the back of this page if necessary.

QUANTITATIVE SKILLS INVENTORY FOR ECONOMICS MAJORS

I. Please indicate for each course listed below whether it is required, recommended but not required, or not essential for an Economics major at your institution. Place a check in the appropriate box.

	Required	Recommended but Not required	Not Essential
Algebra			
Calculus			
Statistics			
Linear Algebra			
Differential Equations			
Computer Programming			
Computer Tools (e.g. spread-sheets)			
Econometrics			

II. In what department are the students advised to take their quantitative courses? Place a check in the appropriate box.

	Math. or Comp. Sci.	Econ.	Psych.	Other	Other Bus. area
Calculus					
Statistics					
Linear algebra					
Computer Programing					
Computer tools					

(OVER)